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## PATENT SPECIFICATION



Application Date: Dec. 15, 1941. No. 16180/41.

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### PROVISIONAL SPECIFICATION

#### Improvements in or relating to Flexible Hose for Conveying Fluid at High Pressures

We, AUTOMOTIVE PRODUCTS COMPANY LIMITED, a British Company, of Tachbrook Road, Leamington Spa, in the County of Warwick, and EDWARD CLAUDE SHAKESPEARE CLENCH, a British Subject, of the Company's address, do hereby declare the nature of this invention to be as follows:—

This invention relates to flexible hose for conveying fluids at high pressures, such as is used in liquid pressure braking systems for vehicles, and in liquid pressure remote control systems.

Hose for these purposes is commonly made by winding on a tubular core of rubber or equivalent flexible and resilient material a plurality of layers of reinforcing textile threads or metal wires, each layer comprising a number of threads or wires wound helically all parallel to each other to form a continuous helical wrapping, or two sets of threads or wires wound helically in opposite directions and interlaced with each other to form a braiding, or any other suitable combination of threads or wires woven or otherwise combined to form a covering surrounding the core.

In order to enable hoses to be manufactured rapidly, and with the minimum possible number of operations, it is desirable to use the smallest possible number of layers of reinforcing material, not more than four layers being preferable.

To provide adequate strength the individual layers must, therefore, be of comparatively coarse threads, but it has been found that if such threads are wound directly on to the rubber core, the latter, which, during the curing or vulcanising process to which the hose is subjected after the reinforcing material has been applied is heated to a highly plastic state and is under considerable pressure, is liable to be forced through the interstices of the reinforcing layers, thus spoiling the continuity of the core and rendering it extremely weak.

It is the object of the present invention to provide a hose in which the material of the core cannot be forced through the interstices of the surround-

ing reinforcing material, and, with this object in view, the present invention consists in providing between the core and the reinforcing layers an intermediate layer of braided fabric which, by reason of the fineness of the threads from which it is formed, and/or the closeness with which the threads are braided together forms a substantially impervious covering for the core.

The intermediate layer may be of insufficient strength to add appreciably to the resistance of the hose to bursting, but with certain core materials it may be sufficient to provide a closely braided layer of relatively coarse threads which will provide considerable resistance to bursting.

In one form of hose according to the invention, the intermediate layer is formed by winding two sets of threads helically in opposite directions about the core, and interlacing them to form a braided covering. The subsequent layers consist each of threads or wires wound helically side by side all parallel to each other to form a continuous wrapping each layer being preferably wound in the opposite direction to the previous layer. It has been found that such helical threads or wires provide a hose having a lesser degree of volumetric expansion under pressure than do corresponding threads braided together, and low expansion is of great importance in hoses used for liquid pressure braking systems, but it is difficult to obtain a sufficiently impervious covering with such helical wrappings to prevent the core material from being forced between the threads. The intermediate layer of braided threads, however, forms an effective obstruction to the penetration by the core material into the wrappings.

In another form of hose according to the invention, the reinforcing material consists entirely of layers of braided threads or wires, but in order to render necessary only a small number of layers, the threads or wires are of relatively coarse gauge, and the interstices between them are relatively large. An inter-

mediate layer of much finer threads, also braided, is therefore applied to the core of the hose before the main braiding is applied, and this intermediate layer effectively prevents the penetration of the core material into the reinforcing layers.

Dated this 15th day of December, 1941.  
For the Applicants,  
**F. J. CLEVELAND & COMPANY,**  
Chartered Patent Agents,  
29, Southampton Buildings,  
Chancery Lane, London, W.C.2.

## COMPLETE SPECIFICATION

### Improvements in or relating to Flexible Hose for Conveying Fluid at High Pressures

We, AUTOMOTIVE PRODUCTS COMPANY LIMITED, a British Company, of Tachbrook Road, Leamington Spa, in the 10 County of Warwick, and EDWARD CLAUDE SHAKESPEARE CLENCH, a British Subject, of the Company's address, do hereby declare the nature of this invention and in what manner the same is to be performed 15 to be particularly described and ascertained in and by the following statement:—

This invention relates to flexible hose 20 for conveying fluids at high pressures, such as is used in liquid pressure braking systems for vehicles, and in liquid pressure control systems.

The hose to which the invention relates 25 is of the kind in which a plurality of layers of reinforcing textile threads or metal wires are wound on a tubular core of rubber or equivalent flexible and resilient material, each layer comprising 30 either a number of threads or wires wound helically all parallel to each other to form a continuous helical wrapping, or two sets of threads or wires wound helically in opposite directions and interlaced with each other to form a braiding, 35 the reinforcing layers being wound on the core prior to the curing of the latter.

In order to enable hoses to be manufactured rapidly, and with the minimum 40 possible number of operations, it is desirable to use the smallest possible number of layers of reinforcing material, not more than four layers being preferable. To provide adequate strength the individual layers must, therefore, be of comparatively coarse threads, but it has been found that if such threads are wound directly on to the rubber core, the latter, which, during the curing or vulcanising 45 process to which the hose is subjected after the reinforcing material has been applied, is heated to a highly plastic state and is under considerable pressure, is liable to be forced through the inter- 50 stices of the reinforcing layers, thus spoiling the continuity of the core and rendering it extremely weak.

It is the object of the present invention to provide a hose in which the material of the core cannot be forced through the 60 interstices of the surrounding reinforcing material, and, with this object in view, the present invention is characterised in that between the core and the reinforcing layers there is an intermediate layer 70 formed by braiding closely on the core textile threads of sufficient fineness to prevent the material of the core from being forced through the interstices thereof during the curing of the hose. 75

According to one form of the invention, a flexible hose of the kind referred to having each of the reinforcing layers constituted by a continuous helical wrapping, is characterised by the feature that 80 between the core and the inner helical wrapping there is provided an intermediate layer of braided textile threads.

According to another form of the invention, a flexible hose of the kind referred to having each of the reinforcing layers constituted by relatively coarse braided textile threads of metal wires, is characterised by the feature that between the core and the inner reinforcing braid- 90 ing is formed an intermediate layer of relatively fine and closely braided textile threads.

The intermediate layer may be formed of threads having insufficient strength to 95 add substantially to the strength of the hose.

A flexible hose has previously been proposed in which the reinforcement is composed of layers of wire mesh strip 100 wound helically between alternate layers of rubber, a layer composed of a plurality of thicknesses of rubberised duck being disposed between the innermost wire mesh reinforcing layer and the 105 innermost rubber layer or core which constitutes the interior wall of the hose.

The invention is hereinafter described with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic illustration on an enlarged scale of one form of

hose according to the invention, the various reinforcing layers being cut away to show the inner layers; and

5 Figure 2 is a similar illustration of another form of hose according to the invention.

In the form of hose shown in Figure 1, the intermediate layer 10 is formed by winding two sets of threads helically 10 in opposite directions about the core 11, and interlacing them in the known manner to form a braided covering. The subsequent layers 12, 13 and 14 consist each of threads or wires wound helically 15 side by side all parallel to each other to form a continuous wrapping, each layer being preferably wound in the opposite direction to the previous layer. It has been found that such helical threads or 20 wires provide a hose having a lesser degree of volumetric expansion under pressure than do corresponding threads braided together, and low expansion is of great importance in hoses used for 25 liquid pressure braking systems, but it is difficult to obtain a sufficiently impervious covering with such helical wrappings to prevent the core material from being forced between the threads. 30 The intermediate layer 10 of braided threads, however, forms an effective obstruction to the penetration by the core material into the wrappings.

The hose is formed by first of all 35 extending on a mandrel a tube of suitable rubber to form the core 11. The layer of braided threads 10 is applied in a braiding machine and the reinforcing layers 12, 13 and 14 are then wrapped 40 over the braided layer. An outer covering of rubber may be applied if desired, but is not shown in the drawing. The hose is then subjected to heat and pressure to cure the rubber. During the curing process, the rubber reaches a highly 45 plastic state, in which it flows readily, and would force its way between the wrapped threads if it were directly in contact with them. In the intermediate 50 layer of braiding, however, the threads, being interlaced, are held firmly together, and the threads are selected of a suitable thickness to ensure that the interstices between them are too small to allow passage 55 of the rubber.

In another form of hose, shown in Figure 2, the reinforcing material consists entirely of layers of braided threads or wires, but in order to render necessary 60 only a small number of layers, the threads or wires are of relatively coarse gauge, and the interstices between them are relatively large. An intermediate layer of much finer threads, also braided, is 65 therefore applied to the core 11 of the

hose before the main braiding is applied, as at 15 in the drawing, and this intermediate layer effectively prevents the penetration of the core material into the reinforcing layers. The main braiding 70 layers are shown at 16 and 17 respectively, and an outer rubber covering is shown at 18. The process of manufacturing this hose is similar to that described in connection with the previous 75 example, but the reinforcing layers are, of course, applied by means of a braiding machine.

The intermediate layer of braiding is preferably made as flat as possible, by 80 utilising a number of fine threads laid side-by-side on each spindle of the braiding machine. The flatness of the layer is assisted by employing soft or relatively soft threads which flatten out under 85 pressure, and close up the very small gaps which inevitably occur at the crossings of the threads. A very satisfactory intermediate layer may be formed by a braiding comprising single threads of soft 90 material, but it is preferred to use groups of threads, for example five, in which case it has been found possible to use a somewhat harder thread than can be used if the braiding is formed of single 95 threads. In both arrangements shown on the drawings, the intermediate layer 10 is formed by braiding groups of five threads.

Having now particularly described and 100 ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A flexible hose of the kind referred 105 to, characterised in that between the core and the reinforcing layers there is an intermediate layer formed by braiding closely on the core textile threads of sufficient fineness to prevent the material of the core from being forced through the interstices thereof during the curing of 110 the hose.

2. A flexible hose of the kind referred 115 to having each of the reinforcing layers constituted by a continuous helical wrapping, characterised by the feature that between the core and the inner helical wrapping there is provided an intermediate layer of closely braided textile 120 threads.

3. A flexible hose of the kind referred 125 to having each of the reinforcing layers constituted by relatively coarse braided textile threads or metal wires, characterised by the feature that between the core and the inner reinforcing braiding is formed an intermediate layer of relatively fine and closely braided textile threads.

4. A flexible hose, according to any of 130

Claims 1, 2 and 3, wherein the intermediate layer is formed of threads having insufficient strength to add substantially to the strength of the hose.

5 5. A flexible hose, according to any of Claims 1 to 4, wherein the intermediate layer of braided threads is formed by grouping a plurality of fine threads side-by-side on each spindle of the braiding machine.

10 6. A flexible hose, according to Claim 2, having an intermediate layer of braided textile threads between the core and the reinforcing layers, substantially as de-

scribed herein and as shown in Figure 1 of the accompanying drawing.

7. A flexible hose according to Claim 3, having an intermediate layer of braided textile threads between the core and the 15 reinforcing layers, substantially as described herein and as shown in Figure 2 of the accompanying drawing.

Dated this 26th day of August, 1942.

For the Applicants,  
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*[This Drawing is a reproduction of the Original on a reduced scale.]*

Fig. 1.

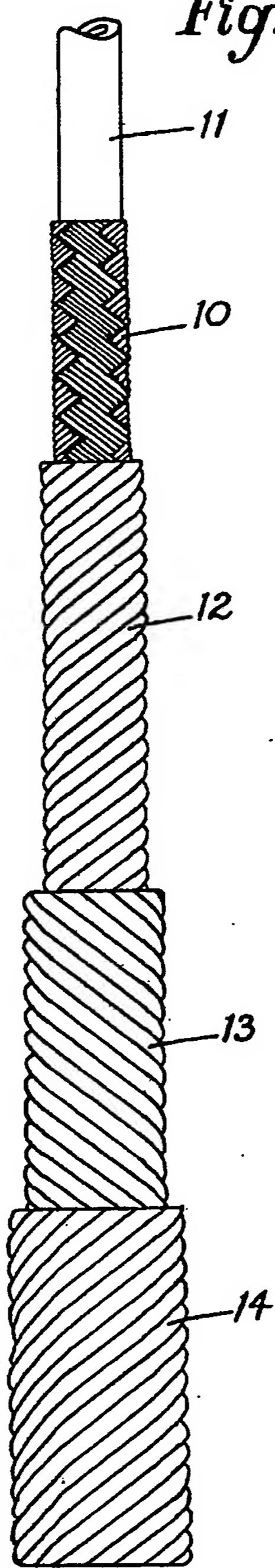


Fig. 2.

